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(54) [Title of the Invention]

PICTURE ELEMENT DEFECT CORRECTING DEVICE

(57) [Abstract]

[Problem to be solved]

To provide a pixel defect correcting device that can perform a pixel defect correcting process more efficiently by speeding up a discrimination process for a normal pixel for replacement.

[Solution]

The pixel defect correcting device comprises a frame memory 5 for capturing a pixel signal from an image pickup device 2 as image data via an analog processing circuit 3 and an A/D converter 4, and a system controller 9 for performing the pixel defect correction of replacing pixel data of a defective pixel with pixel data of a normal pixel for the image data captured into the frame memory 5, based on defective pixel coordinate data in a defective pixel coordinate data table and positional data of the normal pixel

for replacement, with defective pixel coordinate data in the horizontal direction and the vertical direction of the image pickup device 2 and the positional data of the normal pixel to replace the defective pixel as the defective pixel coordinate data table in a table memory, wherein the image data on which this system controller 9 performs the pixel defect correcting process is outputted as an ordinary image data from the frame memory 5.

[Claims for the Patent]

[Claim 1]

A pixel defect correcting device comprising:

pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory;

pixel defect correcting means for performing a pixel defect correcting process of replacing pixel data of a defective pixel with pixel data of a normal pixel for the image data captured into said frame memory, based on coordinate data of the defective pixel and positional data of the normal pixel in a defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of the defective pixel and the positional data of the normal pixel to replace said defective pixel in said image pickup device; and

image data output means for outputting the image data on which the pixel defect correcting process is performed by said pixel defect correcting means as an ordinary image data.

[Claim 2]

A pixel defect correcting device comprising:

pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory;

pixel defect correcting means for performing a pixel defect correcting process by referring to only a table required to perform thinning reading in a designated mode in a plurality of tables provided for a defective pixel coordinate data table, with said defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in said image pickup device as the plurality of tables corresponding to thinning reading modes; and

image data output means for outputting the image data on which the pixel defect correcting process is performed by said pixel defect correcting means as an ordinary image data.

[Claim 3]

A pixel defect correcting device comprising:

pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory;

pixel defect correcting means for performing a pixel defect correcting process by referring to only a table required to perform a partial reading designated in a plurality of tables provided for a defective pixel coordinate data table, with said defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in said image pickup device as the plurality of tables arranged for every horizontal or vertical coordinate; and

image data output means for outputting the image data on which the pixel defect correcting process is performed by said pixel defect correcting means as an ordinary image data.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

The present invention relates to a pixel defect correcting device, and more particularly to a pixel defect correcting device for correcting a defective pixel of an image pickup device to output it as ordinary image data.

[0002]

[Conventional Art]

A solid-state image pickup device such as a CCD consists of a number of photoelectric conversion elements arranged on a semiconductor substrate, and has the advantage that it is much smaller, lighter and cheaper than a pickup tube used from old times, whereby it is widely used in various fields such as a television camera and an image sensor.

[0003]

Recently, it is required that such image pickup device is as small as possible, and has high sensitivity and high image quality, whereby a number of micro pixels are incorporated into a small chip. Therefore, it is susceptible to a crystal defect of the semiconductor substrate, a pattern failure, or the dust adhering to the substrate surface, for example, thereby often producing a defective pixel where the photoelectric conversion can not be normally made, which was one cause of inhibiting the increased yield in the productivity.

[0004]

Thus, to improve the yield, technical means for relieving a defective pixel by replacing pixel data read from the defective pixel with pixel data read from a normal pixel has been described in Japanese Patent Application Laid-Open No. 5-68209, Japanese Patent Application Laid-Open No. 5-48974, Japanese Patent Application Laid-Open No. 5-236358, and Japanese Patent Application Laid-Open No. 6-6643, for example.

[0005]

The overall configuration of the conventional pixel defect correcting device will be described below, using a block diagram of Figure 1 showing an embodiment of the invention.

[0006]

This pixel defect correcting device comprises a lens system 1 for forming an incident optical image of the subject, an image pickup device 2 for making the photoelectric conversion of a subject image formed by this lens system 1 to output an electric signal, an analog processing circuit 3 for aligning the output from the image pickup device 2 with the input level of an A/D converter 4 by making the amplification or optical black clamp, the A/D converter 4 for converting an analog signal outputted from this analog processing circuit 3 into a digital signal, a frame memory 5 for once storing the picked up image data, a display memory 6 for storing the data displayed on a monitor, an output processing circuit 7 for converting and outputting the image data from this display memory 6 according to the standards for a monitor and the like (typically converting it into an analog signal through the D/A conversion and adding a synchronization signal), a system controller for managing an operation mode of this pixel defect correcting device and performing a pixel defect correcting process, an image pickup device drive circuit 8 for driving the image pickup device 2 at a timing according to the mode with a mode signal outputted from this system controller 9 to read a signal, and a personal computer interface (personal computer I/F) 10, connected to a bus with the system controller 9 and the frame memory 5, for transferring the pixel defect corrected image via a unit according to the standards such as SCSI to a personal computer.

[0007]

The overall operation of the pixel defect correcting device will be described below.

[0008]

The subject image formed on an image pickup surface of the image pickup device 2 by the lens system 1 is converted from optical to electrical form by the image pickup device 2 and outputted as an electrical signal. This outputted signal is amplified by the analog processing circuit 3, subjected to an analog processing such as optical black clamp, and converted into digital data by the A/D converter 4.

[0009]

This digital data is once stored in the frame memory 5, and subjected to a pixel defect correcting process as will be described later by the system controller 9. The defect corrected image data is outputted from the frame memory 5, and the data used for display is stored in the display memory 6.

[0010]

The display memory 6 reads out the image data according to a display timing and sends it out to the output processing circuit 7.

[0011]

The output processing circuit 7 converts a digital signal received from the display memory 6 into an analog signal, adds a synchronization signal to it, and outputs a video signal to display means such as a monitor.

[0012]

Also, the defect corrected data stored in the frame memory 5 is transferred through the personal computer I/F 10 to an external device such as a personal computer, and outputted as a print image by a printer, for example, connected to the personal computer.

[0013]

Referring to a flowchart of Figure 11, the internal operation of the system controller 9 within the conventional pixel defect correcting device will be described below.

[0014]

A pixel signal picked up by the image pickup device 2 is transferred via the analog processing circuit 3 and the A/D converter 4 to the frame memory 5 (step S51).

[0015]

Subsequently, it is judged whether or not there is left coordinate data to refer to in a table (defective pixel coordinate data table) storing coordinate data of defective pixel as shown in Figure 12 (step S52). If referring to the coordinate data of all the defective pixels is ended, the procedure goes to step S56.

[0016]

On the other hand, if there is left the coordinate data to refer to, the horizontal coordinate data and the vertical coordinate data of the defective pixel are acquired from the defective pixel coordinate data table as shown in Figure 12 (step S53).

[0017]

And the pixel data of the normal pixel is acquired from the peripheral pixels around the acquired coordinate data of the defective pixel (step S54). Usually, if the pixel directly left or right adjacent to the defective pixel is the normal pixel, its pixel data is acquired.

[0018]

At this time, a judgment whether or not the pixel from which the pixel data is acquired is the normal pixel is made by considering that the pixel is the normal pixel if there is no coordinate in the defective pixel coordinate data table coincident with the coordinate of the pixel data to be acquired by referring to the defective pixel coordinate data table as shown in Figure 12.

[0019]

Next, the pixel data at the coordinate position of the defective pixel at step S53 is replaced with the pixel data of the normal pixel acquired at step S54 (step S55).

[0020]

Turning back to step S52, the processing from step S52 to step S55 is repeated until there is no coordinate data to refer to.

[0021]

And if acquiring the coordinate data at all the pixel defect positions from the defective pixel coordinate data table is ended at step S52, the image data having ended the pixel defect correcting process through step S52 to step S55 is outputted from the frame memory 5 to the output device such as a monitor or personal computer (step S56), and this procedure is ended.

[0022]

[Problems to be solved by the invention]

With the conventional pixel defect correcting device as described above, in replacing the defective pixel with the peripheral normal pixel, a discrimination whether or not the pixel for replacement is the normal pixel is made by retrieving the coordinate data of the defective pixel in the defective pixel coordinate data table, and judging that the pixel is the normal pixel if the same coordinate data does not exist. However, such discrimination means must discriminate whether or not the pixel is the normal pixel by collating the coordinate data of the pixel for replacement with all the coordinate data in the data table for all the defective pixels, whereby there is a problem that it takes a long time to perform the overall pixel defect correcting process.

[0023]

Also, with the conventional pixel defect correcting device, in making the thinning reading or block reading, the coordinate data of the pixel for replacement is collated with all the coordinate data in the data table for all the defective pixels including the defective pixels other than the reading object, whereby there is a problem that it takes a long time to perform the overall pixel defect correcting process.

[0024]

This invention has been achieved in the light of the above-mentioned problems, and it is an object of the invention to provide a pixel defect correcting device that can perform the pixel defect correction in a short time more efficiently.

[0025]

[Means for solving the problems]

In order to accomplish the above object, the invention of claim 1 provides a pixel defect correcting device comprising pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory, pixel defect correcting means for performing a pixel defect correcting process of replacing pixel data of a defective pixel with pixel data of a normal pixel for the image data captured into the frame memory, based on coordinate data of the defective pixel and positional data of the normal pixel in a defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of the defective pixel and the positional data of the normal pixel to replace the defective pixel in the image pickup device, and image data output means for outputting the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as an ordinary image data.

[0026]

Also, the invention of claim 2 provides a pixel defect correcting device comprising pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory, pixel defect correcting means for performing a pixel defect correcting process by referring to only a table required to perform thinning reading in a designated mode in a plurality of tables provided for a defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in the image pickup device as the plurality of tables corresponding to thinning reading modes, and image data output means for outputting the image data on which the pixel defect correcting process is performed by the pixel defect correcting means as an ordinary image data.

[0027]

Further, the invention of claim 3 provides a pixel defect correcting device comprising pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory, pixel defect correcting means for performing a pixel defect correcting process by referring to only a table required to perform a partial reading designated in a plurality of tables provided for a defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in the image pickup device as the plurality of tables arranged for every horizontal or vertical coordinate, and image data output means for outputting the image data on which the pixel defect correcting process is performed by the pixel defect correcting means as an ordinary image data.

[0028]

Accordingly, in the pixel defect correcting device according to the invention of claim 1, the pixel data capturing means captures a pixel signal from the image pickup device as image data into the frame memory, the pixel defect correcting means performs the pixel defect correcting process of replacing the pixel data of a defective pixel with the pixel data of a normal pixel for the image data captured into the frame memory, based on the coordinate data of the defective pixel and the positional data of the normal pixel in the defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of the defective pixel and the positional data of the normal pixel to replace the defective pixel in the image pickup device, and the image data output means outputs the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as the ordinary image data.

[0029]

Also, in the pixel defect correcting device according to the invention of claim 2, the pixel data capturing means captures a pixel signal from the image pickup device as image data into the frame memory, the pixel defect correcting means performs the pixel defect correcting process by referring to only a table required to perform the thinning reading in a designated mode in a plurality of tables provided for the defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in the image pickup device as the plurality of tables corresponding to the thinning reading modes, and the image data output means outputs the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as the ordinary image data.

[0030]

Further, in the pixel defect correcting device according to the invention of claim 3, the pixel data capturing means captures a pixel signal from the image pickup device as image data into the frame memory, the pixel defect correcting means performs the pixel defect correcting process by referring to only a table required to perform a partial reading designated in a plurality of tables provided for the defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in the image pickup device as the plurality of tables arranged for every horizontal or vertical coordinate, and the image data output means outputs the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as the ordinary image data.

[0031]

[Embodiments of the Invention]

The embodiments of the present invention will be described below with reference to the drawings. Figures 1 to 4 show a first embodiment of the invention. Figure 1 is a block diagram showing the configuration of a pixel defect correcting device, Figure 2 is a flowchart showing the operation of a pixel defect correcting process with a system controller, Figure 3 is a view showing a defective pixel coordinate data table and Figure 4 is a view showing the replacement positions allocated around a defective pixel.

[0032]

This pixel defect correcting device comprises a lens system 1 for forming an incident optical image of the subject, an image pickup device 2 for making the photoelectric conversion of a subject image formed by this lens system 1 to output an electric signal, an analog processing circuit 3 for aligning the output from the image pickup device 2 with the input level of an A/D converter 4 by making the amplification or optical black clamp, the A/D converter 4 for converting an analog signal outputted from this analog processing circuit 3 into a digital signal, a frame memory 5 serving as pixel data capturing means for once storing the picked up image data and image data output means, a display memory 6 for storing the data displayed on a monitor, an output processing circuit 7 for converting and outputting the image data from this display memory 6 according to the standards for a monitor and the like (typically converting it into an analog signal through the D/A conversion and adding a synchronization signal), a system controller serving as pixel defect correcting means for managing an operation mode of this pixel defect correcting device, and performing a pixel defect correcting process, with a table memory storing a defective pixel coordinate data table described later, an image pickup device drive circuit 8 for driving the image pickup device 2 at a timing according to the mode with a mode signal outputted from this system controller 9 to read a signal, and a personal computer interface (personal computer I/F) 10, connected to a bus with the system controller 9 and the frame memory 5, for transferring the pixel defect corrected image via a unit according to the standards such as SCSI to a personal computer, as shown in Figure 1.

[0033]

The overall operation of the pixel defect correcting device as shown in Figure 1 will be described below.

[0034]

That is, the subject image formed on the image pickup surface of the image pickup device 2 by the lens system 1 is converted from optical to electrical form by the image pickup device 2 and outputted as an electrical signal. This outputted signal is amplified by the analog processing circuit 3, subjected to an analog processing such as optical black clamp, and converted into digital data by the A/D converter 4.

[0035]

This digital data is once stored in the frame memory 5, and subjected to a pixel defect correcting process as will be described later by the system controller 9. The defect corrected image data is outputted from the frame memory 5, and the data used for display is stored in the display memory 6.

[0036]

The display memory 6 reads out the image data according to the display timing and sends it out to the output processing circuit 7.

[0037]

The output processing circuit 7 converts a digital signal received from the display memory 6 into an analog signal, adds a synchronization signal to it, and outputs a video signal to display means such as a monitor.

[0038]

Also, the defect corrected data stored in the frame memory 5 is transferred through the personal computer I/F 10 to an external device such as a personal computer, and outputted as a print image by a printer, for example, connected to the personal computer.

[0039]

Referring to a flowchart of Figure 2, the operation of the system controller 9 within the pixel defect correcting device of the embodiment will be described below.

[0040]

The image data picked up by the image pickup device 2 is captured via the analog processing circuit 3 and the A/D converter 4 into the frame memory 5 (step S1).

[0041]

Subsequently, it is judged whether or not there is left coordinate data to refer to in a defective pixel coordinate data table as shown in Figure 3 (step S2). If referring to the coordinate data of all the defective pixels is ended, the procedure goes to step S7.

[0042]

On the other hand, if there is left the coordinate data to refer to, the horizontal coordinate data and the vertical coordinate data of the defective pixel are captured from the defective pixel coordinate data table as shown in Figure 3 (step S3).

[0043]

And the replacement position data stored in the replacement position item indicating the position of the normal pixel to replace the pixel data of the defective pixel with the pixel data of the normal pixel is acquired from the defective pixel coordinate data table as shown in Figure 3 (step S4).

[0044]

Subsequently, the pixel data of the normal pixel at the position indicated by the acquired replacement position data is acquired (step S5).

[0045]

Herein, for the replacement position data stored in the replacement position item in the defective pixel coordinate data table, the replacement position is specified by numbering the peripheral pixel positions around the position of the defective pixel, such as the left pixel position as 1, the right pixel position as 2, the lower pixel position as 3, the upper pixel position as 4, the upper left pixel position as 5, the upper right pixel position as 6, the lower left pixel position as 7 and the lower right pixel position as 8, as shown in Figure 4, for example.

[0046]

After acquiring the pixel data of the normal pixel in this manner, the pixel data at the coordinate position of the defective pixel on the frame memory 5 is replaced with the pixel data of the normal pixel acquired at step S5 (step S6).

[0047]

Turning back to step S2, the processing from step S2 to step S6 is repeated until there is no coordinate data to refer to.

[0048]

And if there is no coordinate data to refer to in the defective pixel coordinate data table at step S2, the image data for which the pixel defect correcting process is performed is outputted from the frame memory 5 (step S7), and the procedure is ended.

[0049]

With this first embodiment, when the pixel data of the defective pixel is replaced with the pixel data of the normal pixel, it is not required that the coordinate data of pixel for replacement is collated with all the coordinate data in the defective pixel coordinate data table for all the defective pixels, and the position of pixel for replacement is definite beforehand, whereby it is possible to shorten the time for performing the pixel defect correcting process.

[0050]

Figures 5 to 7 show a second embodiment of the invention. Figure 5 is a flowchart showing the operation of a pixel defect correcting process with a system controller, Figure 6 is a view showing a defective pixel coordinate data table with four choices in making the 1/2 thinning reading, and Figure 7 is a view showing a defective pixel coordinate data table in making the $1/2^n$ thinning reading.

[0051]

In this second embodiment, the explanation for the same parts as in the first embodiment is omitted, and only the different points will be mainly described below.

[0052]

The pixel defect correcting device of this embodiment can suitably deal with a thinning mode of performing the thinning reading, with the same configuration as shown in Figure 1.

[0053]

Referring to a flowchart of Figure 5, the operation of the system controller 9 within the pixel defect correcting device of this embodiment will be described below.

[0054]

The image data picked up by the image pickup device 2 is captured via the analog processing circuit 3 and the A/D converter 4 into the frame memory 5 (step S11).

[0055]

Subsequently, the defective pixel coordinate data table is selected in displaying the image data captured at step S11 in the thinning mode (step S12).

[0056]

Usually, one defective pixel coordinate data table includes the coordinate data of every defective pixel for all the pixels of the image pickup device 2. The defective pixel coordinate data table at this time is shown in Figure 6, when the horizontal and vertical pixels of the image data in the frame memory 5 are outputted by 1/2 thinning, for example.

[0057]

That is, for the coordinate data of the defective pixel, one table is selected from a total of four tables, including one table in which horizontal coordinate data is even and vertical coordinate data is even, one table in which horizontal coordinate data is even and vertical coordinate data is odd, one table in which horizontal coordinate data is odd and vertical coordinate data is even, and one table in which horizontal coordinate data is odd and vertical coordinate data is odd.

[0058]

Next, it is judged whether or not there is left coordinate data to refer to in the selected defective pixel coordinate data table (step S13). If referring to the coordinate data of all the defective pixels is ended, the procedure goes to step S17.

[0059]

On the other hand, if there is left the coordinate data to refer to, the horizontal coordinate data and the vertical coordinate data of the defective pixel are captured from the selected defective pixel coordinate data table (step S14).

[0060]

And the normal pixel around the defective pixel is retrieved to acquire the pixel data (step S15).

[0061]

The pixel data at the coordinate position of the defective pixel in the frame memory 5 is replaced with the pixel data of the normal pixel acquired at step S15 (step S16).

[0062]

Turning back to step S13, the processing from step S13 to step S15 is repeated until there is no coordinate data to refer to.

[0063]

And if there is no coordinate data to refer to in the defective pixel coordinate data table at step S13, the image data for which the pixel defect correcting process is performed is outputted from the frame memory 5 (step S17), and the procedure is ended.

[0064]

In addition to the 1/2 thinning mode, when the contents of the frame memory 5 are outputted in multiple thinning modes, namely, by selecting one thinning mode from among multiple thinning modes such as 1/2 thinning, 1/4 thinning, .., 1/2^n (where the sign ^ denotes the power, hereinafter the same will apply), for example, the coordinate data subjected to the pixel defect correction in each thinning mode is stored in each table, and the defective pixel coordinate data table is composed of these tables, whereby the pixel defect correcting process can be performed by referring to the table corresponding to each thinning mode, as shown in Figure 7.

[0065]

At this time, the same coordinate data exists in each table of the defective pixel coordinate data table, but to avoid overlapping of the coordinate data in each table, the table for 1/2^n thinning of the horizontal and vertical pixels is arranged at the top, and next the table for 1/2^(n-1) thinning is arranged to store only the coordinate data not overlapping the data of 1/2^n among the defective pixel coordinate data of 1/2^(n-1). Similarly, coordinate data is successively stored in each table to avoid overlapping of data.

[0066]

And when the pixel defect correcting process is performed using the defective pixel coordinate data table in a designated thinning mode, the coordinate data is referred to successively, starting from the first table of the tables arranged in the above manner up to the table corresponding to the designated thinning mode, whereby all the coordinate data of the defective pixel of object in the thinning mode can be referred to without overlapping.

[0067]

Though the normal pixel around the defective pixel is retrieved to acquire the pixel data in the above embodiment, the data indicating the replacement position as shown in Figure 3 in the first embodiment may be stored in the data within each table as shown in Figures 6 and 7, whereby the efficiency can be further improved.

[0068]

With the second embodiment, when the pixel defect correcting process is performed in the thinning mode, the pixel defect correcting process is not performed for the pixel out of object, whereby the process can be performed efficiently.

[0069]

Figures 8 to 10 show a third embodiment of the invention. Figure 8 is a flowchart showing the operation of a pixel defect correcting process with a system controller, Figure 9 is a view showing a defective pixel coordinate data table configured in every row direction (vertical direction), and Figure 10 is a view showing a defective pixel coordinate data table configured in every column direction (horizontal direction).

[0070]

In this third embodiment, the explanation for the same parts as in the first and second embodiments described above is omitted, and only the different points will be mainly described below.

[0071]

The pixel defect correcting device of this embodiment can suitably deal with the partial reading, and has a defective pixel coordinate data table classified for every row or column using a pointer, with the same electrical configuration of the pixel defect correcting device as shown in Figure 1.

[0072]

Referring to a flowchart of Figure 8, the operation of the system controller 9 within the pixel defect correcting device of this embodiment will be described below.

[0073]

The image data picked up by the image pickup device 2 is captured via the analog processing circuit 3 and the A/D converter 4 into the frame memory 5 (step S21).

[0074]

The horizontal (row)/vertical (column) start coordinate and end coordinate for reading and displaying a part of the image data in the frame memory 5 are set up (step S22).

[0075]

A pointer to the defective pixel coordinate data table in the start row is acquired from a defective pixel coordinate data index table as shown in Figure 9 (step S23).

[0076]

Subsequently, it is judged whether or not the row of the currently acquired pointer to the defective pixel coordinate data table is the end row (step S24). If it is the end row, the procedure goes to step S30.

[0077]

On the other hand, if it is not the end row, it is judged whether or not there is coordinate data of the defective pixel from the currently acquired pointer to the defective pixel coordinate data table (step S25). If there is no coordinate data, the procedure goes to step S29.

[0078]

Also, if there is coordinate data of the defective pixel, the coordinate data is acquired from the defective pixel coordinate data table of Figure 9 pointed to by the pointer (step S26).

[0079]

It is judged whether or not the coordinate data of the defective pixel acquired in this manner is within the range from the start row of the partial reading to the end row (step S27). If it is within the range, the pixel defect correcting process is performed (step S28), or if it is not within the range, the processing at step S28 is not performed. Then, the procedure returns to step S25.

[0080]

The pixel detect correcting process at step S28 is the same as the processing described from step S54 to step S55 in Figure 11, whereby the pixel data of the normal pixel is acquired from the peripheral pixels around the acquired coordinate data of the defective pixel, and the pixel data at the coordinate position of the defective pixel is replaced with the acquired pixel data of the normal pixel.

[0081]

And if all the coordinate data is processed and there is no unprocessed data at step S25, the pointer to the defective pixel coordinate table in the next row is obtained from the defective pixel coordinate index table (step S29), and the procedure returns to step S24.

[0082]

And if the pointer to the defective pixel coordinate data table obtained at step S29 is the end row at step S24, the contents of the frame memory 5 are outputted (step S30), and this procedure is ended.

[0083]

Though the defective pixel coordinate data table configured in every row direction (vertical direction) as shown in Figure 9 is employed in the above, the defective pixel coordinate data table configured in every column direction (horizontal direction) as shown in Figure 10 may be employed.

[0084]

Also, though the normal pixel around the defective pixel is retrieved to acquire the pixel data in the above, the data indicating the replacement position as shown in Figure 3 in the first embodiment may be stored in the data of each table as shown in Figures 9 and 10, whereby the efficiency can be improved.

[0085]

With the third embodiment, in making the pixel defect correction at the time of outputting the image data by the partial reading, it is not required to perform the pixel defect correction for the row data or column data outside the range of displaying the image data, whereby the processing can be sped up.

[0086]

The embodiments as detailed above may include the following inventions.

[0087]

(1) A pixel defect correcting device comprising pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory, pixel defect correcting means for performing a pixel defect correcting process of replacing the pixel data of a defective pixel with the pixel data of a normal pixel for the image data captured into the frame memory, based on the coordinate data of the defective pixel and the positional data of the normal pixel in a defective pixel coordinate data table, with the defective pixel coordinate data table including

horizontal and vertical coordinate data of the defective pixel and the positional data of the normal pixel to replace the defective pixel in the image pickup device, and image data output means for outputting the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as the ordinary image data.

[0088]

(2) A pixel defect correcting device comprising pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory, pixel defect correcting means for performing a pixel defect correcting process by referring to only a table required to perform the thinning reading in a designated mode in a plurality of tables provided for a defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in the image pickup device as the plurality of tables corresponding to the thinning reading modes, and image data output means for outputting the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as the ordinary image data.

[0089]

(3) A pixel defect correcting device comprising pixel data capturing means for capturing a pixel signal from an image pickup device as image data into a frame memory, pixel defect correcting means for performing a pixel defect correcting process by referring to only a table required

to perform a partial reading designated in a plurality of tables provided for a defective pixel coordinate data table, with the defective pixel coordinate data table including horizontal and vertical coordinate data of a defective pixel in the image pickup device as the plurality of tables arranged for every horizontal or vertical coordinate, and image data output means for outputting the image data for which the pixel defect correcting process is performed by the pixel defect correcting means as the ordinary image data.

[0090]

(4) The pixel defect correcting device according to (2), wherein the pixel defect correcting means further performs the pixel defect correcting process of replacing the pixel data of the defective pixel with the pixel data of the normal pixel for the image data captured into the frame memory, based on the coordinate data of the defective pixel and the positional data of the normal pixel in the defective pixel coordinate data table, with the defective pixel coordinate data table including the positional data of the normal pixel to replace the defective pixel.

[0091]

(5) The pixel defect correcting device according to (3), wherein the pixel defect correcting means further performs the pixel defect correcting process of replacing the pixel data of the defective pixel with the pixel data of the normal pixel for the image data captured into the frame memory, based on the coordinate data of the defective

pixel and the positional data of the normal pixel in the defective pixel coordinate data table, with the defective pixel coordinate data table including the positional data of the normal pixel to replace the defective pixel.

[0092]

(6) The pixel defect correcting device according to (2) or (4), wherein the plurality of tables corresponding to the thinning reading modes provided for the defective pixel coordinate data table are stored so that the data within each table may not overlap.

[0093]

(7) The pixel defect correcting device according to (6), wherein the pixel defect correcting means performs the pixel defect correcting process by referring to one of four tables in outputting the image data in the 1/2 thinning reading mode, with the defective pixel coordinate data table including a table in which horizontal coordinate data is even and vertical coordinate data is even, a table in which horizontal coordinate data is even and vertical coordinate data is odd, a table in which horizontal coordinate data is odd and vertical coordinate data is even, and a table in which horizontal coordinate data is odd and vertical coordinate data is odd, as the plurality of tables corresponding to the thinning reading modes.

[0094]

(8) The pixel defect correcting device according to (6), wherein the pixel defect correcting means performs the

pixel defect correcting process by referring to the tables for 1/2^k thinning from k=n to k=m in outputting the image data in the 1/2^m (n≥m≥1) thinning mode, with the defective pixel coordinate data table including n tables for 1/2^k (k=n, n-1, ..,1) (n is the natural number, the sign ^ denotes the power) thinning in which the table for 1/2^(k-1) thinning is configured without overlapping of the stored data with the table for 1/2^k thinning and a table without thinning as the plurality of tables corresponding to the thinning reading modes.

[0095]

(9) The pixel defect correcting device according to (3) or (5), wherein the selection of the table required for the partial reading among the plurality of tables provided for the defective pixel coordinate data table is made by referring to an index table having an initial address of coordinate data in the horizontal or vertical direction.

[0096]

(10) The pixel defect correcting device according to (1), (4) or (5), wherein the positional data of the normal pixel is the number sequentially given to each pixel located near the defective pixel.

[0097]

With the invention according to (1), when the pixel data of the defective pixel is replaced with the pixel data of the normal pixel, the positional data of the normal pixel for replacement is known beforehand, whereby it is unnecessary to judge whether or not the pixel is the normal pixel by referring to the defective pixel coordinate data table, so that the processing time can be shortened.

[0098]

With the invention according to (2), in the case where there are multiple thinning reading modes, the coordinate data of the defective pixel corresponding to each mode is collected in each table, whereby it is required to refer to only the necessary table, not the unnecessary tables, so that the pixel defect correcting process can be made efficiently.

[0099]

With the invention according to (3), in the case where the partial reading is made, it is required to refer to only the table necessary to perform the partial reading, not the unnecessary tables, among plural tables in which the coordinate data of the defective pixel is collected for every horizontal or vertical coordinate, so that the pixel defect correcting process can be made efficiently.

[0100]

With the invention according to (4), in addition to the same effects of the invention according to (2), when the pixel data of the defective pixel is replaced with the pixel data of the normal pixel, the positional data of the normal pixel for replacement is known beforehand, whereby it is unnecessary to judge whether or not the pixel is the normal pixel by referring to the defective pixel coordinate data table, so that the processing time can be further shortened.

[0101]

With the invention according to (5), in addition to the same effects of the invention according to (3), when the pixel data of the defective pixel is replaced with the pixel data of the normal pixel, the positional data of the normal pixel for replacement is known beforehand, whereby it is unnecessary to judge whether or not the pixel is the normal pixel by referring to the defective pixel coordinate data table, so that the processing time can be further shortened.

[0102]

With the invention according to (6), in addition to the same effects of the invention according to (2) or (4), the overlapping of the same coordinate data does not exist in each table corresponding to the thinning reading mode provided for the defective pixel coordinate data table, whereby the amount of data in the defective pixel coordinate data table is reduced, so that the pixel defect correcting process can be made efficiently.

[0103]

With the invention according to (7), in addition to the same effects of the invention according to (6), when the horizontal pixel and the vertical pixel is subjected to the 1/2 thinning reading that is the thinning reading at high use frequency, it is required to refer to only one table of processing object, so that the pixel defect correcting process can be made efficiently.

[0104]

With the invention according to (8), in addition to the same effects of the invention according to (6), when the 1/2^m thinning reading is performed, it is required to refer to the tables for 1/2^k thinning (k=n, .., m), without overlapping of data in each table, so that the pixel defect correcting process can be made efficiently.

[0105]

With the invention according to (9), in addition to the same effects of the invention according to (3) or (5), the selection of the table required for the partial reading is made by referring to the index table, without reading the data of the unnecessary table, whereby the amount of processing data is reduced, so that the time taken for the pixel defect correcting process can be shortened.

[0106]

(10) With the invention according to (10), in addition to the same effects of the invention according to (1), (4) or (5), the position of the normal pixel for replacement can be specified with smaller amount of data.

[0107]

[Advantages of the Invention]

As described above, with the pixel defect correcting device according to the invention of claim 1, when the pixel data of the defective pixel is replaced with the pixel data of the normal pixel, the positional data of the normal pixel for replacement is known beforehand, whereby it is unnecessary to judge whether or not the pixel is the normal pixel by referring to the defective pixel coordinate data table, so that the processing time can be shortened.

[0108]

Also, with the pixel defect correcting device according to the invention of claim 2, in the case where there are multiple thinning reading modes, the coordinate data of the defective pixel corresponding to each mode is collected in each table, whereby it is required to refer to only the necessary table, not the unnecessary tables, so that the pixel defect correcting process can be made efficiently.

[0109]

Also, with the pixel defect correcting device according to the invention of claim 3, in the case where the partial reading is made, it is required to refer to only the table necessary to perform the partial reading, not the unnecessary tables, among plural tables in which the coordinate data of the defective pixel is collected for every horizontal or vertical coordinate, so that the pixel defect correcting process can be made efficiently.

[Brief Description of the Drawings]

[Figure 1]

Figure 1 is a block diagram showing the configuration of a pixel defect correcting device according to a first embodiment of the present invention.

[Figure 2]

Figure 2 is a flowchart showing the operation of a pixel defect correcting process with a system controller according to the first embodiment.

[Figure 3]

Figure 3 is a view showing a defective pixel coordinate data table according to the first embodiment.

[Figure 4]

Figure 4 is a view showing the replacement positions allocated around the defective pixel according to the first embodiment.

[Figure 5]

Figure 5 is a flowchart showing the operation of a pixel defect correcting process with a system controller according to a second embodiment of the invention.

[Figure 6]

Figure 6 is a view showing a defective pixel coordinate data table with four choices in making the 1/2 thinning reading according to the second embodiment.

[Figure 7]

Figure 7 is a view showing a defective pixel coordinate data table in making the $1/2^n$ thinning reading according to the second embodiment.

[Figure 8]

Figure 8 is a flowchart showing the operation of a pixel defect correcting process with a system controller according to a third embodiment of the invention.

[Figure 9]

Figure 9 is a view showing a defective pixel coordinate data table configured in every row direction (vertical direction) according to the third embodiment.

[Figure 10]

Figure 10 is a view showing a defective pixel coordinate data table configured in every column direction (horizontal direction) according to the third embodiment.

[Figure 11]

Figure 11 is a flowchart showing the operation of a pixel defect correcting process with a system controller in the conventional pixel defect correcting device.

[Figure 12]

Figure 12 is a view showing the conventional defective pixel coordinate data table.

[Description of Symbols]

1	lens system
2	image pickup device
3	analog processing circuit
4	A/D converter
5	frame memory (pixel data capturing means, image data output means)
6	display memory
7	output processing circuit
8	image pickup device drive circuit
9	system controller (pixel defect correcting means)
10	personal computer interface

Figure 1

1 Lens system
2 Image pickup device
3 Analog processing
4 A/D conversion
5 Frame memory
6 Display memory
7 Output processing
8 Image pickup device drive circuit
9 System controller
#1 Table memory
10 Personal computer I/F
#2 Output of video signal (to monitor)
#3 To personal computer

Figure 2

#1 Pixel defect correcting process

S1 Capture image data from image pickup device into image memory

S2 No coordinate data?

S3 Acquire coordinate data of defective pixel from defective pixel coordinate data table

S4 Acquire item data at replacement position of defective pixel coordinate data table

S5 Acquire image data with the pixel at position indicated by item data at replacement position as normal pixel

S6 Replace pixel data of normal pixel at coordinate position of defective pixel

S7 Output the contents of image memory

#2 End

Figure 3

#1 Defective pixel coordinate data table

#2 Defective pixel coordinate data

#3 Horizontal coordinate

#4 Vertical coordinate

#5 Replacement position

Figure 4

#1 Defective pixel

Figure 5

#1 Pixel defect correcting process

S11 Capture image data from image pickup device into image memory

S12 Select pixel defect coordinate data table

S13 No coordinate data?

S14 Acquire coordinate data of defective pixel from defective pixel coordinate data table

S15 Retrieve the normal pixel around defective pixel and acquire pixel data

S16 Insert pixel data of normal pixel into coordinate of defective pixel

S17 Output the contents of image memory

#2 End

Figure 6

#1 Defective pixel coordinate data table

#2 Horizontal pixel (even), vertical pixel (even)

#3 Horizontal pixel (even), vertical pixel (odd)

#4 Horizontal pixel (odd), vertical pixel (even)

#5 Horizontal pixel (odd), vertical pixel (odd)

Figure 7

#1 Horizontal/vertical pixel, defective pixel coordinate data table for $1/2^n$ thinning

#2 Horizontal/vertical pixel, defective pixel coordinate data table for $1/2^3$ thinning

#3 Horizontal/vertical pixel, defective pixel coordinate data table for $1/2^2$ thinning

#4 Horizontal/vertical pixel, defective pixel coordinate data table for 1/2 thinning

#5 Horizontal/vertical pixel, defective pixel coordinate data table for no thinning

Figure 8

#1 Pixel defect correcting process

S21 Capture image data from image pickup device into image memory

S22 Set start coordinate and end coordinate to make partial reading

S23 Acquire the pointer to defect pixel coordinate data table of start line from defective pixel coordinate data index table

S24 End line?

S25 No coordinate data?

S26 Acquire coordinate data from defective pixel coordinate data table pointed to by pointer

S27 Is the line out of the range from start line to end line?

S28 Pixel defect correcting process

S29 Acquire the pointer to defect pixel coordinate data table of next line

S30 Output the contents of frame memory

#2 End

Figure 9

#1 Defective pixel coordinate data index table

#2 Pointer to defective pixel coordinate data of first line

#3 Pointer to defective pixel coordinate data of second line

#4 Pointer to defective pixel coordinate data of third line

#5 Pointer to defective pixel coordinate data of n-th line

#6 Defective pixel coordinate data table

#7 Defective pixel coordinate data of first line
#8 Defective pixel coordinate data of second line
#9 Defective pixel coordinate data of third line
#10 Defective pixel coordinate data of n-th line

Figure 10
#1 Defective pixel coordinate data index table
#2 Pointer to defective pixel coordinate data of first line
#3 Pointer to defective pixel coordinate data of second line
#4 Pointer to defective pixel coordinate data of third line
#5 Pointer to defective pixel coordinate data of n-th line
#6 Defective pixel coordinate data table
#7 Defective pixel coordinate data of first line
#8 Defective pixel coordinate data of second line
#9 Defective pixel coordinate data of third line
#10 Defective pixel coordinate data of n-th line

Figure 11
#1 Pixel defect correcting process
S51 Capture pixel data from image pickup device into image memory
S52 No coordinate data?
S53 Acquire coordinate data of defective pixel from defective pixel coordinate data table

S54 Retrieve the normal pixel around defective pixel and acquire pixel data

S55 Insert pixel data of normal pixel into coordinate of defective pixel

S56 Output the contents of image memory

#2 End

Figure 12

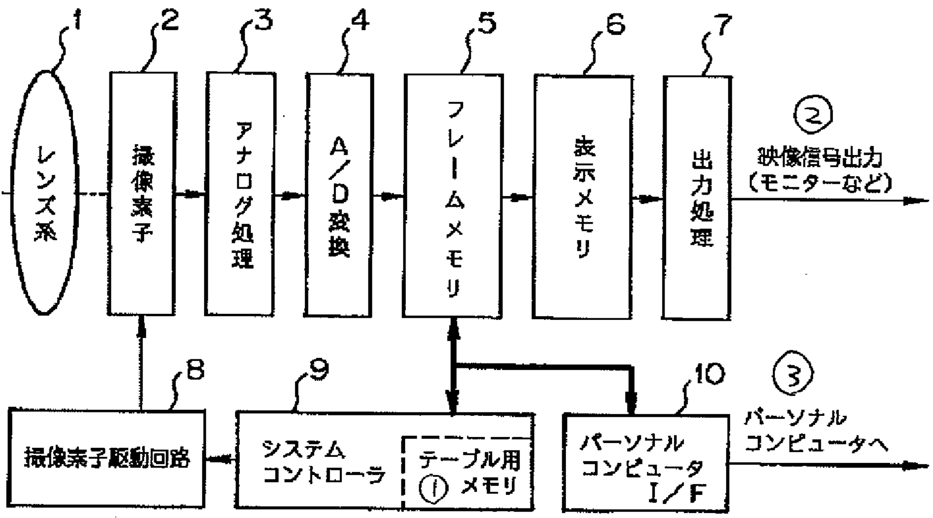
#1 Defective pixel coordinate data table

#2 Defective pixel coordinate data

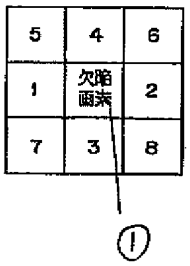
#3 Horizontal coordinate

#4 Vertical coordinate

【図1】 Fig.1


1
2
3
4
5
6
7
レンズ系
撮像素子
アナログ処理
A／D変換
フレームメモリ
表示メモリ
出力処理
②
映像信号出力
（モニターなど）
8
9
10
③
撮像素子駆動回路
システムコントローラ
テーブル用メモリ
①
パーソナルコンピュータI／F
パーソナルコンピュータへ

【図4】 Fig.4


5
4
6
1
欠陥画素
2
7
3
8
①

【図2】 Fig2

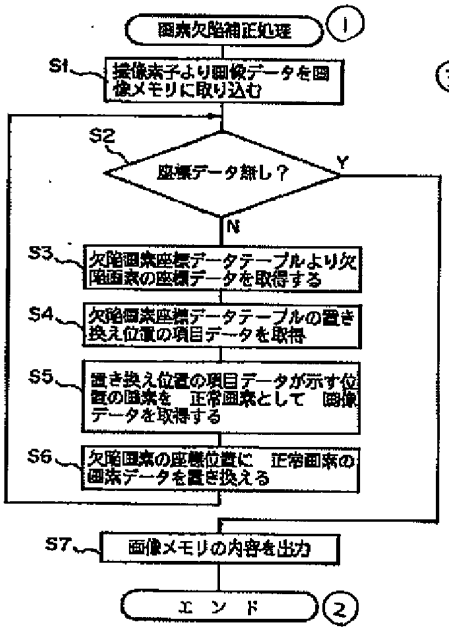

画素欠陥補正処理
①
S1
撮像素子より画像データを画像メモリに取り込む
S2
座標データ無し？
Y
N
S3
欠陥画素座標データテーブルより欠陥画素の座標データを取得する
S4
欠陥画素座標データテーブルの置き換え位置の項目データを取得
S5
置き換え位置の項目データが示す位置の画素を　正常画素として　画像データを取得する
S6
欠陥画素の座標位置に　正常画素の画素データを置き換える
S7
画像メモリの内容を出力
エンド
②

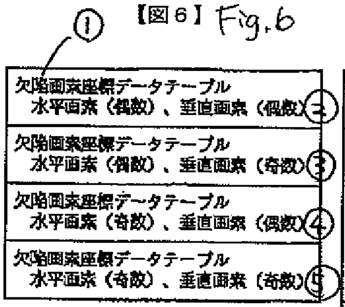
Fig.3
【図3】

①

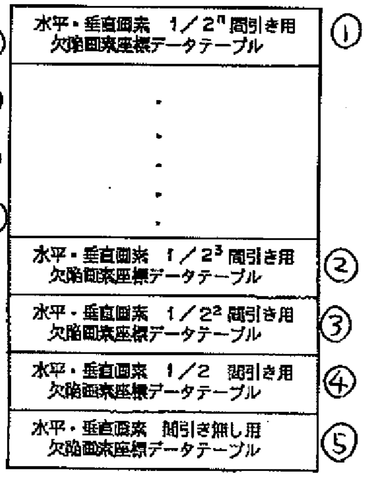
欠陥画素座標データテーブル

	欠陥画素座標データ ②		
③	水平方向の座標	垂直方向の座標 ④	置き換え位置 ⑤
1	x1	y1	1
2	x2	y2	1
3	x3	y3	2
⋮	～	～	～
n	xn	yn	5

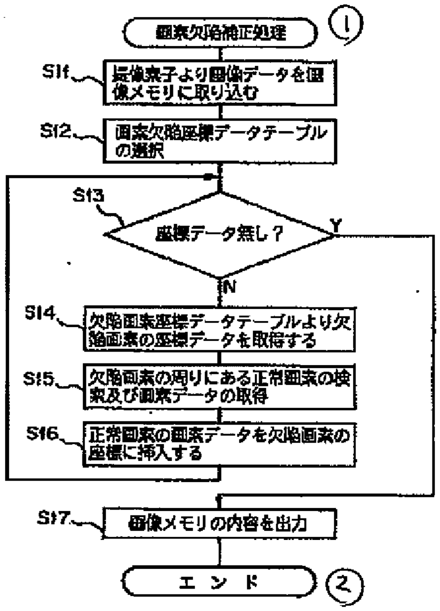
【図6】 Fig.6


①
欠陥画素座標データテーブル
水平画素（偶数）、垂直画素（偶数）
②
欠陥画素座標データテーブル
水平画素（偶数）、垂直画素（奇数）
③
欠陥画素座標データテーブル
水平画素（奇数）、垂直画素（偶数）
④
欠陥画素座標データテーブル
水平画素（奇数）、垂直画素（奇数）
⑤

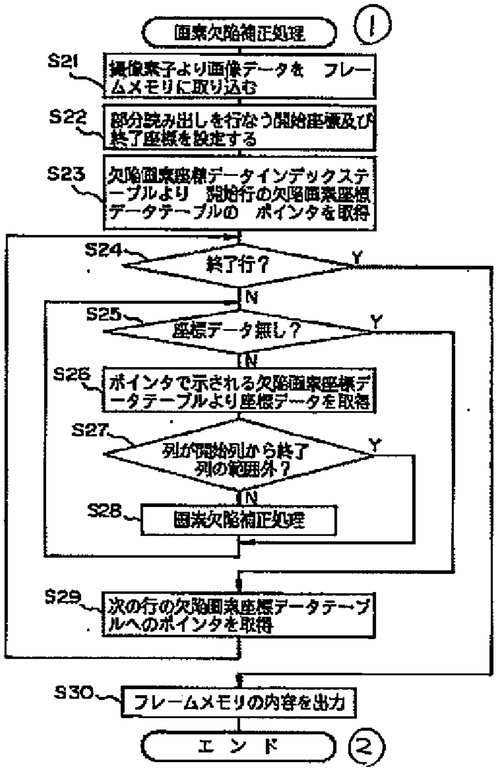
【図7】 Fig.7.


水平・垂直画素　1／2ⁿ間引き用
欠陥画素座標データテーブル
①
水平・垂直画素　1／2³間引き用
欠陥画素座標データテーブル
②
水平・垂直画素　1／2²間引き用
欠陥画素座標データテーブル
③
水平・垂直画素　1／2　間引き用
欠陥画素座標データテーブル
④
水平・垂直画素　間引き無し用
欠陥画素座標データテーブル
⑤

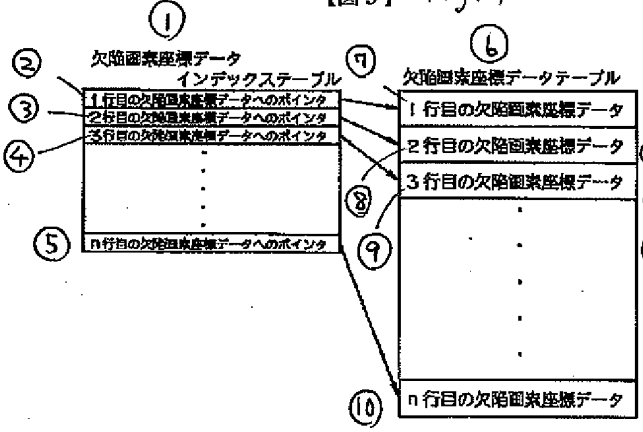
【図5】 Fig.5


①
画素欠陥補正処理
S11
撮像素子より画像データを画像メモリに取り込む
S12
画素欠陥座標データテーブルの選択
S13
座標データ無し？
Y
N
S14
欠陥画素座標データテーブルより欠陥画素の座標データを取得する
S15
欠陥画素の周りにある正常画素の検索及び画素データの取得
S16
正常画素の画素データを欠陥画素の座標に挿入する
S17
画像メモリの内容を出力
エンド
②

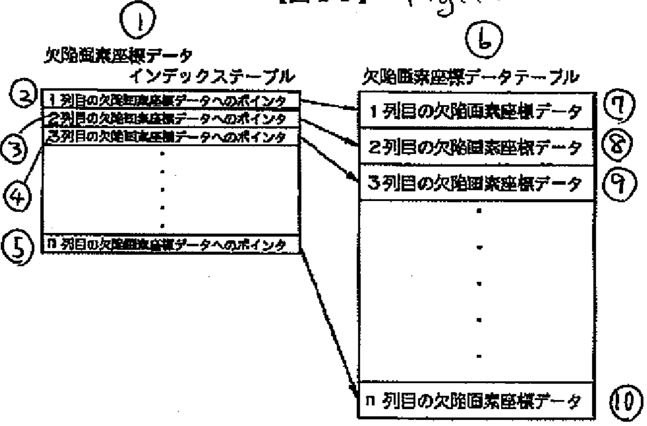
【図8】 Fig.8


①
画素欠陥補正処理
S21
撮像素子より画像データを フレームメモリに取り込む
S22
部分読み出しを行なう開始座標及び終了座標を設定する
S23
欠陥画素座標データインデックステーブルより 開始行の欠陥画素座標データテーブルの ポインタを取得
S24
終了行？
Y
N
S25
座標データ無し？
Y
N
S26
ポインタで示される欠陥画素座標データテーブルより座標データを取得
S27
列が開始列から終了列の範囲外？
Y
N
S28
画素欠陥補正処理
S29
次の行の欠陥画素座標データテーブルへのポインタを取得
S30
フレームメモリの内容を出力
エンド
②

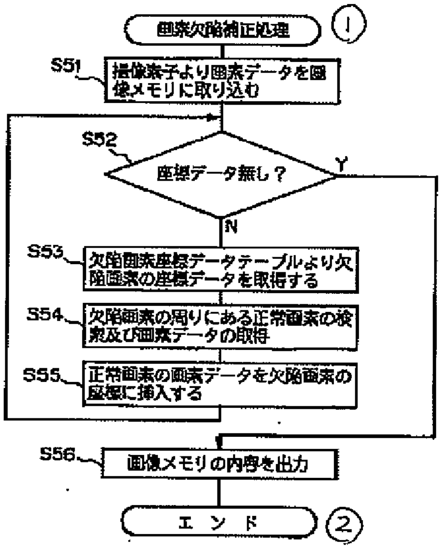
【図9】 Fig.9


①
欠陥画素座標データ
インデックステーブル
②
1行目の欠陥画素座標データへのポインタ
③
2行目の欠陥画素座標データへのポインタ
④
3行目の欠陥画素座標データへのポインタ
⑤
n行目の欠陥画素座標データへのポインタ
⑥
欠陥画素座標データテーブル
⑦
1行目の欠陥画素座標データ
⑧
2行目の欠陥画素座標データ
⑨
3行目の欠陥画素座標データ
⑩
n行目の欠陥画素座標データ

【図10】 Fig.10


①
欠陥画素座標データ
インデックステーブル
②
1列目の欠陥画素座標データへのポインタ
③
2列目の欠陥画素座標データへのポインタ
④
3列目の欠陥画素座標データへのポインタ
⑤
n列目の欠陥画素座標データへのポインタ
⑥
欠陥画素座標データテーブル
⑦
1列目の欠陥画素座標データ
⑧
2列目の欠陥画素座標データ
⑨
3列目の欠陥画素座標データ
⑩
n列目の欠陥画素座標データ

【図１１】 Fig. 11


画素欠陥補正処理
①
S51
撮像素子より画素データを画像メモリに取り込む
S52
座標データ無し？
Y
N
S53
欠陥画素座標データテーブルより欠陥画素の座標データを取得する
S54
欠陥画素の周りにある正常画素の検索及び画素データの取得
S55
正常画素の画素データを欠陥画素の座標に挿入する
S56
画像メモリの内容を出力
エンド
②

【図１２】 Fig. 12

①

欠陥画素座標データテーブル

②

	欠陥画素座標データ		
③	水平方向の座標	垂直方向の座標	④
1	x1	y1	
2	x2	y2	
3	x3	y3	
・ ・	～ ～	～ ～	
n	xn	yn	